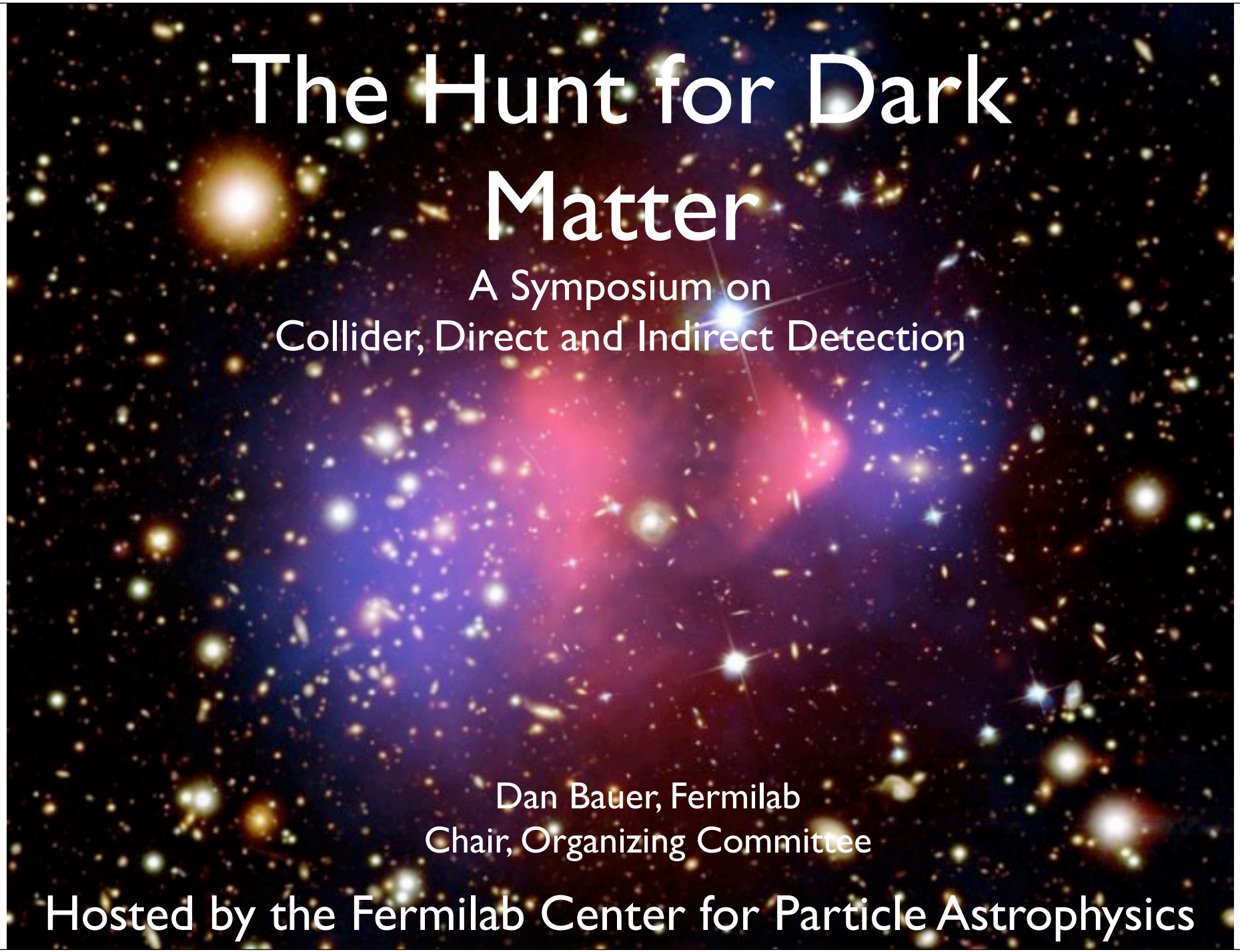


The Hunt for Dark Matter

A Symposium on
Collider, Direct and Indirect Detection

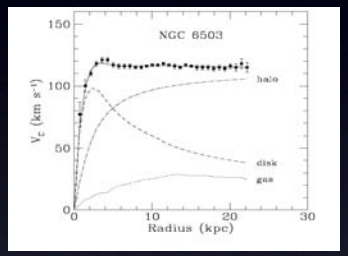
Dan Bauer, Fermilab
Chair, Organizing Committee

Hosted by the Fermilab Center for Particle Astrophysics

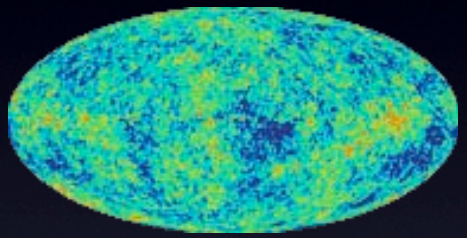
Evidence for Dark Matter

We believe dark matter explains observations of gravitational effects at many scales!

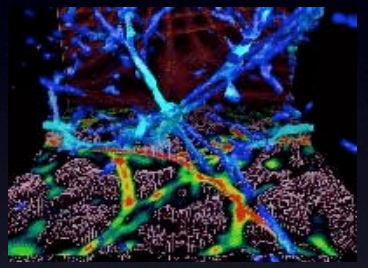
•Rotation curves of galaxies



•CMB



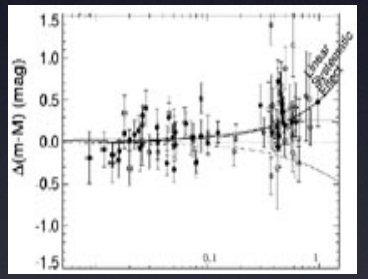
•Large Scale Structure



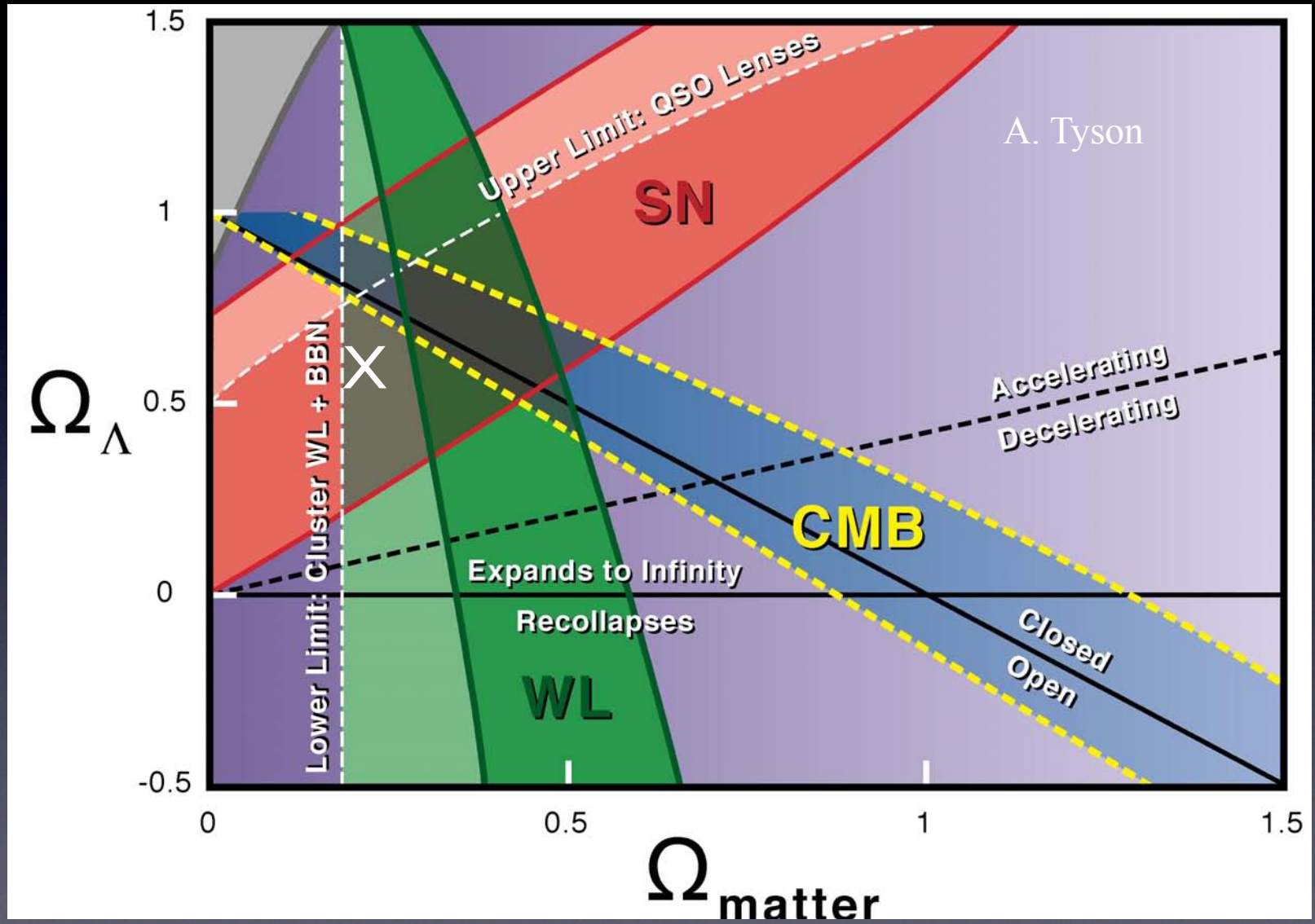
•Galaxy clusters

•Lensing

•SN Ia



Standard Model of Cosmology



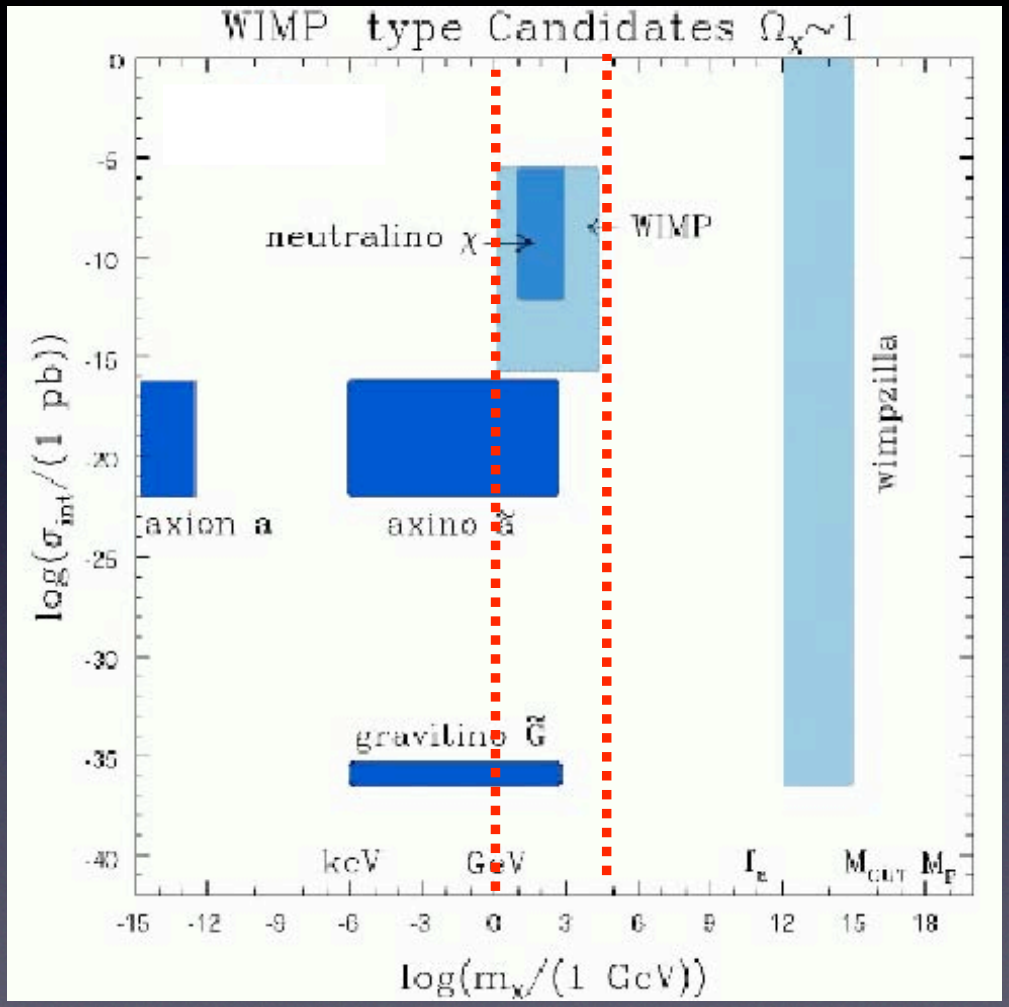
What do we know about dark matter?

- It's cold (mostly not neutrinos)
  - Implied from large scale structure, CMB
- It's mostly not normal baryonic matter
  - From Big-Bang nucleosynthesis, CMB
- It barely responds to any known forces other than gravity
- It might indicate physics beyond the standard model of particle physics (e.g. SUSY)!

Particle Dark Matter Candidates

Theorists have been very active in suggesting candidates!

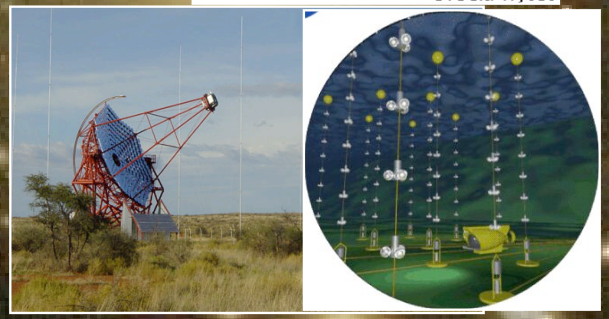
Kaluza-Klein DM in UED
Kaluza-Klein DM in RS
- Axion
- Axino
- Gravitino
- Photino
- SM Neutrino
- Sterile Neutrino
- Sneutrino
- Light DM
- Little Higgs DM
- Wimpzillas
- Q-balls
- Mirror Matter
- Champs (charged DM)
- D-matter
- Cryptons
- Self-interacting
- Superweakly interacting
- Braneworls DM
- Heavy neutrino
- NEUTRALINO
- Messenger States in GMSB
- Branons
- Chaplygin Gas
- Split SUSY
- Primordial Black Holes



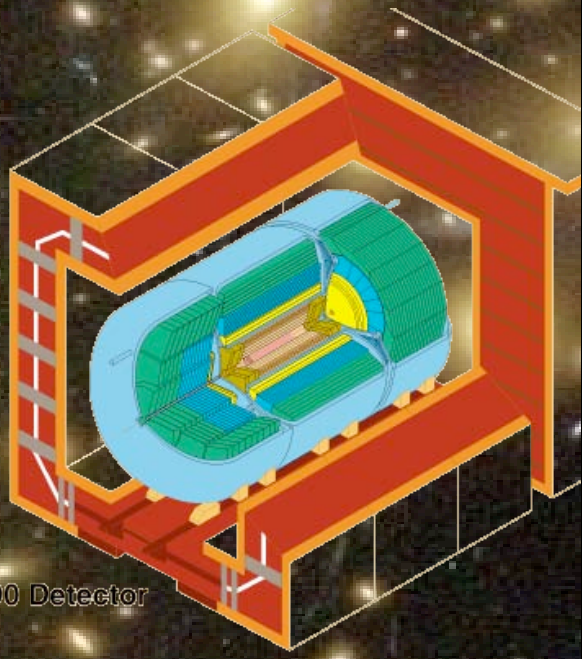
L. Roszkowski, http://www.shef.ac.uk/physics/idm2004/talks/

Many different experimental approaches to dark matter detection!

Direct Detection



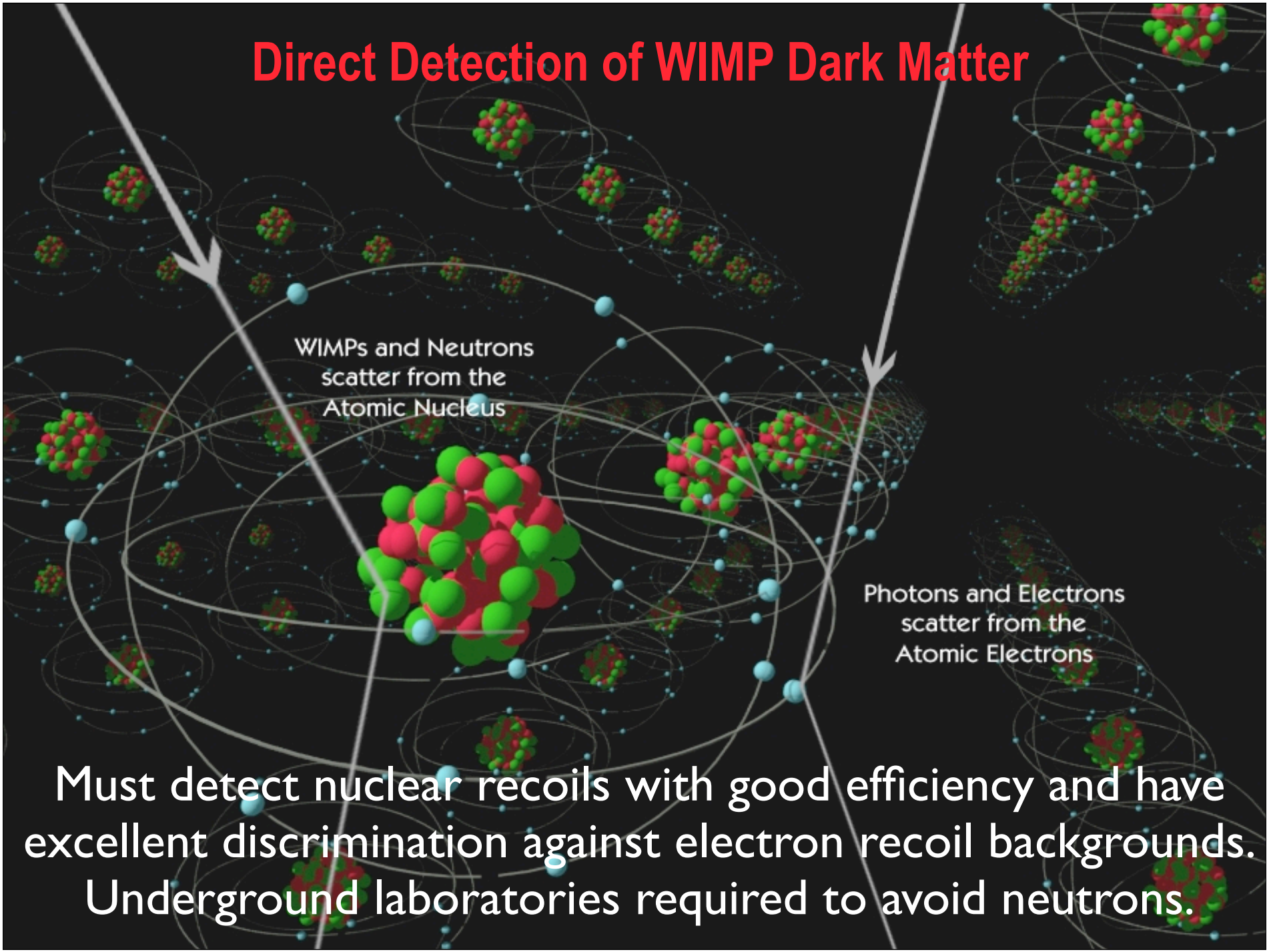
Indirect Detection



Colliders

Astronomy (lensing background)

Direct Detection of WIMP Dark Matter



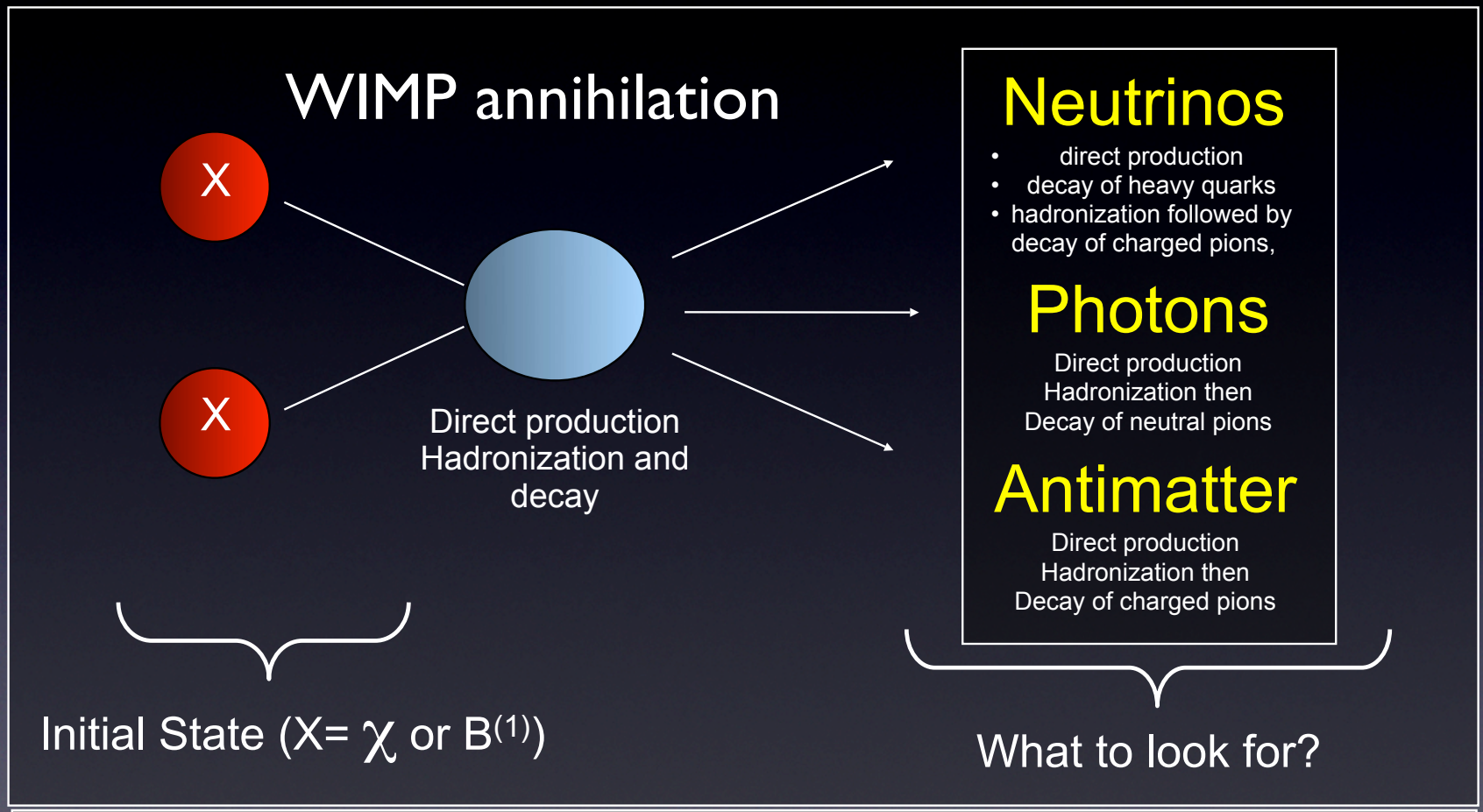
Must detect nuclear recoils with good efficiency and have excellent discrimination against electron recoil backgrounds. Underground laboratories required to avoid neutrons.

Direct Detection

- Goals
  - Directly detect WIMPS as Earth passes through dark matter halo of Milky Way
  - Measure WIMP-nucleon cross section and WIMP mass
- Challenges
  - Very low flux => large target mass, patience
  - Background rates < few events/year!

Indirect Detection of WIMP Dark matter

Goal: Find evidence for the dark matter halo in our galaxy



Main Problems: How to distinguish from other astrophysical processes and where are the best places to look

Colliders

- Goal
  - Produce massive neutral particles (e.g. neutralinos) and measure their properties
- Challenges
  - Do existing machines have mass reach?
  - Indirect detection (missing energy)
  - Can colliders determine if such particles really constitute dark matter?

Why this symposium now?

- Convergence of experimental approaches with similar sensitivities
  - Colliders - Tevatron, LHC
  - Direct Detection - CDMS, Noble Liquids, other techniques
  - Indirect Detection - HESS, Veritas, GLAST, ICECUBE, Pamela,....
  - Astronomy - SDSS and other surveys
- Guidance from theory suggests dark matter detection may be near!

Why Fermilab?

- Fermilab Particle Astrophysics Center
  - Pioneers in particle astrophysics theory
  - Ground-breaking astronomical survey (SDSS)
  - Two strong direct detection experiments (CDMS, COUPP)
- Preeminent collider facility
  - Tevatron CDF/D0 and LHC/CMS groups
- Strong programs at nearby lab and universities
  - ANL, Chicago, Northwestern, UW Madison

Welcome and enjoy the symposium!

- For assistance, contact the conference desk:
  - Cynthia Sazama, Suzanne Weber
- Or any of the local organizing committee:
  - Dan Bauer, Karen Byrum, Marcela Carena, Fritz DeJongh, Dan Hooper, Mark Jackson, Pasquale Serpico, Andrew Sonnenschein